SCUBA Survey of Rockfish Assemblages in the Strait of Georgia, B.C. (Statistical Areas 15 and 16), September to November 1985

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SCUBA SURVEY OF ROCKFISH ASSEMBLAGES IN THE STRAIT OF GEORGIA, B.C. (STATISTICAL AREAS 15 AND 16), SEPTEMBER TO NOVEMBER 1985

by

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ABSTRACT

Richards, L. J., H. I. McElderry, J. Carolsfeld, and C. P. Lauridsen. 1986. Scuba survey of rockfish assemblages in the Strait of Georgia, B.C. (Statistical areas 15 and 16), September to November 1985. Can. Data Rep. Fish. Aquat. Sci. 586 : 112 p.

This report summarizes observations from SCUBA surveys conducted during October and November 1985 at 12 sites in statistical areas 15 and 16 of the Strait of Georgia. A similar survey had been conducted at all but one of these sites during 1984 (Richards et al. 1985b). The surveys were designed to obtain visual estimates of density, species composition and size distribution of near-shore reef-fishes and to make related observations on fish behavior and habitat. Ten 50-m horizontal transects were completed at all sites, at depths between 8 and 16 m. Rockfish (Scorpaenidae) and perch (Embiotocidae) accounted for 92.9% of the fish recorded on the survey. Copper rockfish (Sebastes caurinus) was the most abundant species and accounted for 72.4% of the total; 98% of the copper rockfish were young-of-the-year (<7 cm fork length). Other important species included quillback rockfish (S. maliger), shiner perch (Cymatogaster aggregata), striped perch (Embiotoca lateralis) and pile perch (Rhacochilus vacca). Descriptions of the benthic habitats at the dive sites and raw data on species counts and size distributions are presented in this report.

RESUME

Richards, L. J., H. I. McElderry, J. Carolsfeld, and C. P. Lauridsen. 1986. Scuba survey of rockfish assemblages in the Strait of Georgia, B.C. (Statistical areas 15 and 16), September to November 1985. Can. Data Rep. Fish. Aquat. Sci. 586 : 112 p.

Les auteurs résument les observations faites au cours de relevés par plongeurs autonomes réalisés en octobre et novembre 1985 en 12 points des zones statistiques 15 et 16 du détroit de Géorgie. Un relevé semblable avait été réalisé en 1984; it avait porté sur tous ces points, sauf un (Richards et coll., 1985b). Les relevés étaient conçus de façon à obtenir des estimations visuelles de la densité, de la composition en espèces et de la distribution des tailles des poissons des récifs littoraux, et à faire des observations connexes ayant trait au comportement et à l'habitat des poissons. Les observations ont été faites à partir de dix transects horizontaux de 50 m de longueur et à une profondeur variant de 8 à 16 m, ceci à chacun des sites. Les scorpènes (Scorpénidés) et les perches (Embiotocidés) constituaient 92,9% des poissons aperçus. L'espèce la plus abondante était représentée par le sébaste cuivré (Sebastes caurinus) dont les individus constituainet 72,4% du total; 98% de ces poissons étaient des jeunes de l'année (7 cm à la fourche). On comptait, parmi les autres espèces importantes, le sébaste à dos épineux (S. maliger), la perche-méné (Cymatogaster aggregata), le ditrème rayé (Embiotoca lateralis) et la perche des pilotis (Rhacochilus vacca). On trouve dans le rapport des descriptions des habitats benthiques aux lieux de plongée et les données brutes sur le dénombrement des espèces et la distribution des tailles.

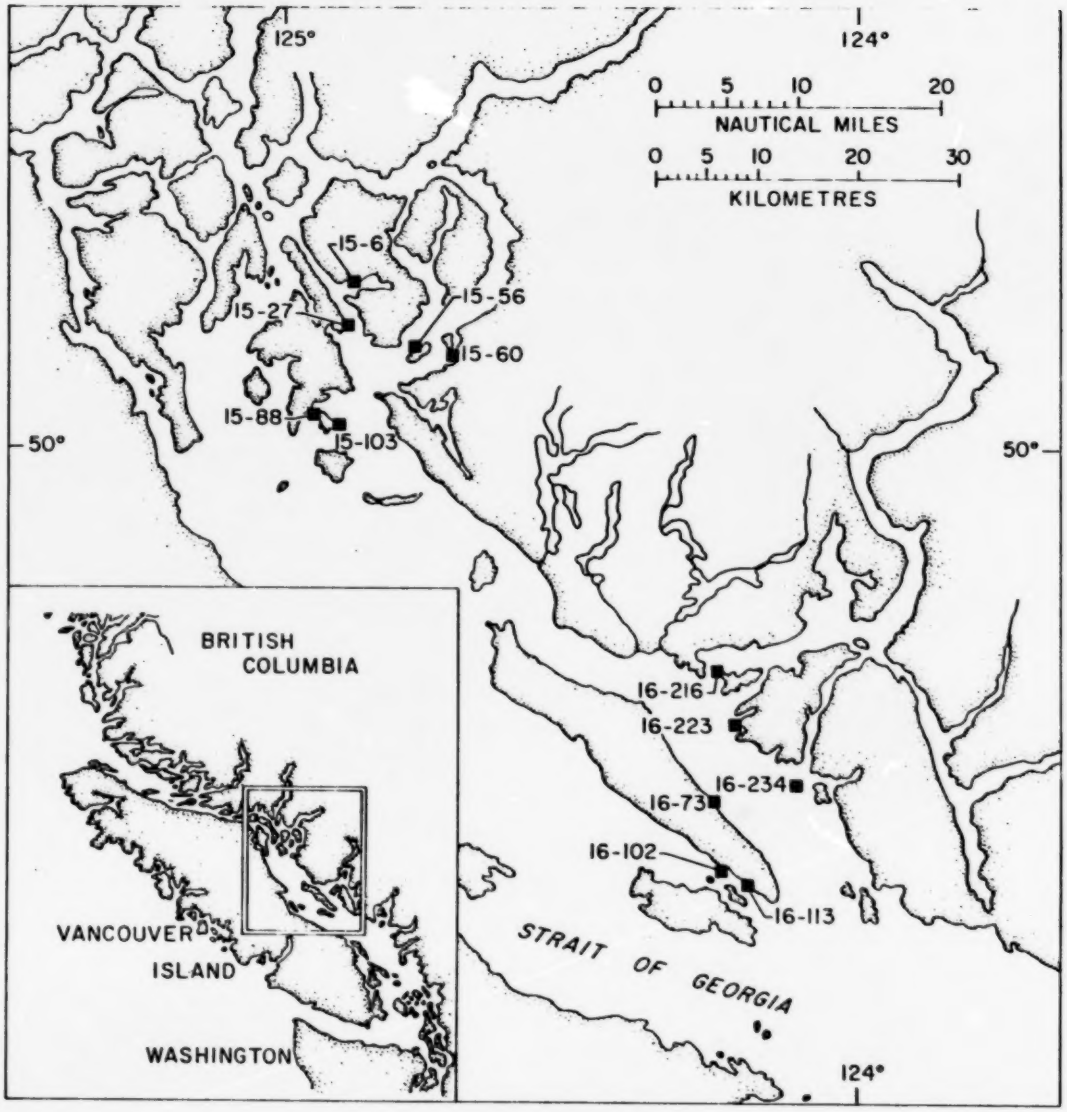

Fig. 1. Site locations for the SCUBA survey.

INTRODUCTION

This report summarizes observations from a SCUBA survey conducted under contract to Archipelago Marine Research of Victoria, B.C. The survey was designed to obtain visual estimates of density, species composition, and size distribution of conspicuous near-shore reef fishes, and to make related observations on fish behavior and habitat. Emphasis was placed on reef-fish species that are important to the commercial and recreational fisheries: rockfish, lingcod and greenling. The survey formed part of a research program on stock assessment of these species. Descriptions of the benthic habitats at the dive sites and raw data on species counts and size distributions are presented in this report.

Field work was performed between October 4 and November 5, 1985, with divers J. Carolsfeld, C. Lauridsen and H. McElderry. Twelve sites were visited in the northern Strait of Georgia, in fisheries statistical areas 15 and 16 (Fig. 1). Prior to this study, SCUBA surveys had been conducted at all but one of these sites during the summer and fall of 1984 (Richards et al. 1985b), and the depths below SCUBA range (20 m) had been surveyed with the submersible PISCES IV (Richards and Cass 1985a). Research hook and line fishing had also been conducted at all sites during both 1984 (Richards et al. 1985a) and 1985 (Richards and Cass 1985b).

METHODS

Survey sites (Fig. 1) were chosen from the sites described by Richards et al. (1985a,b). Each site was defined as a 1'N lat. by 1'W long. rectangular area. Transect positions within each site were chosen by random selection of coordinates using a superimposed grid and a random numbers table. For the Temple Rock site (16-234), there was no associated shoreline, and transect positions were chosen from random compass headings from the shallowest point. Generally, ten positions were selected for each site, equally divided between two depth strata: 6.5 to 11.5 m, and 12.5 to 17.5 m, with depths relative to mean sea level. Swimming direction (left or right) and transect depth (8, 9 or 10 m for shallow and 14, 15 or 16 m for deep transects) were also chosen randomly. However, if a strong tidal current was present, divers chose to swim into the current. Transect starting depths were selected to reduce visual overlap of the two depth strata.

Survey data were collected by two divers along 50-m horizontal transects at each position. Upon arrival at the dive site, divers descended to the predetermined depth that marked the starting point of the transect. Water visibility was measured, and one diver (always H. McElderry) began to unspool the transect tape and to record the fish observed on either side of the transect line. The second diver (J. Carolsfeld or C. Lauridsen) followed behind and recorded algal cover, invertebrate species observed, and pertinent

habitat information. Transects at a given site were completed on at least three different days.

Transect width was not fixed, but depended on visibility. To examine the relationship between visibility and transect width, the distance from the fish to the observer was estimated for all fish seen during 55 of the survey dives. Visibility was measured using a clipboard (21 x 35 cm) that was carried by the diver who recorded invertebrate information. On one side of the clipboard there were a series of alternating 4-cm brown and black bars with a fold-out white card (21 x 35 cm). The clipboard was displayed, with the white card extended. The other diver swam away and recorded the horizontal distance at which the pattern, the slate itself, and the white card could no longer be distinguished.

Fish counts included all rockfish, greenling, lingcod and large sculpins. Other cryptic species such as gobies, flatfish and sculpins were ignored because of the difficulty in obtaining reliable counts. Species such as herring, salmon, perch, dogfish and ratfish were recorded even though the survey method was not designed to assess their densities. The fish observer spent a reasonable amount of time searching for fish in crevices, under rocks and within the macroalgae. Fish were recorded as "off-transect" if they moved into the transect area, were observed outside of the transect area, or were first observed while the diver was retrieving the survey tape. A separate code was also given for young-of-the-year (YOY) copper rockfish that were greater than 2 m away from either side of the transect line, because of the difficulty in assessing the abundance of fish of that size (<7 cm fork length).

Size (fork length) was estimated for all fish observed. The accuracy of size estimates was checked periodically by estimating the size of reef objects that could then be measured. This check probably underestimated diver ability, as the objects measured were stationary (e.g. rocks), and a recognizable fish shape could not be used as a guide to object size. Fish counts were grouped by 5-cm size class for presentation.

Transects were divided according to predefined habitat types. The fish observer was responsible for making habitat divisions and communicating this to the second diver by placing a snap clip onto the transect tape. Fish counts and a description of habitat physiography, plant communities and invertebrate communities were recorded separately for each habitat type along the transect, with the transect length of that habitat type. Habitat measures included slope (±5° from horizontal), relief (an index of bottom irregularity), sediment type and ambient current (cm/s). Plant communities were recorded by morphology and percent of the bottom area covered. Codes used for these habitat measures are described in Table 1.

Invertebrate species (planktonic, epibenthic and inbenthic fauna) were recorded if they were observed within 1.5 m of either side of the transect line. Abundance of each species was averaged over the habitat according to one of three semi-quantitative scales (Table 1). For infaunal species, abundance only included the number that protruded above the surface sediment. To ensure that species were not over-looked, a checklist (Table 2) was prepared prior to initiating the survey and was regularly consulted. Collections were made regularly to minimize observer error between divers and

to verify identifications. Observations made in the same areas by each diver were compared and discussed.

The boat tender collected additional information that was descriptive of the survey conditions. Temperature (±0.5°C) and salinity (±0.1°/$_{oo}$) were recorded at 1-m intervals to a depth of 20 m using a YSI, model 33, temperature-conductivity meter. Surface temperature was verified using a mercury thermometer accurate to 0.2°C. Tide was recorded on an integer scale to represent the number of hours before or after low tide. Other information collected included sea state, surface current, sky conditions, wind direction and wind speed. Codes for this information are described in Table 1.

RESULTS AND DISCUSSION

A total of 120 dives were completed at the 12 sites during the survey. General features of the benthic habitats at the dive sites are summarized by the following descriptions. Counts of each fish species and size composition data are summarized for each site in Tables 3 and 4. Raw data for each transect are presented in Appendices 1-6.

SITE DESCRIPTIONS

Partington Point, Texada Island - Site 16-102

This site consisted of approximately 1300 m of shoreline divided about equally on either side of the Partington Point light. The subtidal substrate was primarily a 30°-50° bedrock slope with a sand-rock interface that became shallower away from the point. The reef surface at the Point had a scoured appearance. Away from the point the reef tended to be silt-covered and littered with wood chip and algal debris. Some of the transected area included sand habitats where few fish were observed. The bay to the south of Partington Light consisted of sand and areas of pebble and boulders. In this region there were large schools of YOY copper rockfish and a few kelp greenling. Overall, the bedrock and substrate varied considerably from a low relief of barren rock to a high relief of rock richly covered by algae and invertebrates. The level of fish abundance appeared to coincide with this pattern.

Texada Island - Southwest side - Site 16-113

This site consisted of approximately 1500 m of shoreline that formed three distinct physiographic units. On the north end of the site there was a vertical wall, indented with crevices and boulder chutes. In most areas the wall descended to a sand/shell bottom, with the interface becoming

shallower to the south. Because of its orientation to Sabine Channel, tidal currents and wave exposure were considerable at this site. The fish community was comprised of herring and tube-snout schools, juvenile and adult copper and quillback rockfish, greenling, lingcod and three perch species.

The second geographic unit which encompassed about half of the shore, consisted of a sheltered bay with a 5° slope of gravel, pebbles and sand. Cover of Agarum and filamentous red algae was generally less than 10%. The few fish observed were juvenile greenling and two species of flatfish.

The third geographic unit at the southern end of the site, was a small reef 20 m offshore. The reef had a rounded top and low sloping sides to a depth of 7 m, and then a bedrock wall that dropped to a boulder base at 13 m. Perch and YOY rockfish were abundant on the sides and upper parts of the wall and adult quillback rockfish were observed in the boulder area below the wall.

Texada Island - Southeast side - Site 16-073

This site consisted of a moderate boulder slope (40-50°) that was relatively uniform over the 500 m shoreline. A sparse Nereocystis forest (10% cover) extended to a depth of 8 m and provided habitat for large numbers of shiner perch and YOY rockfish. Below the Nereocystis, Agarum formed 60-90% cover to a depth of 17 m. There were large numbers of kelp, striped and pile perch, and most sizes of quillback rockfish. Lingcod, greenling and copper rockfish were present but were not abundant.

Strawberry Islets - Site 16-223

This site consisted of three small islets and a short distance of shoreline along Nelson Island. The total shoreline length of 800 m was extremely variable in degree of exposure, type of habitat and presence of marine life. A transect at Strawberry Islet was over broken rock at the base of a steep bedrock wall. The rock was heavily covered by encrusting organisms and there were many quillback and copper rockfish present. Dives conducted on Nelson Island were in a more sheltered area of low-relief 50° bedrock slope that was divided by a 20 m section of shell/sand. At this location fish were not abundant; most common were YOY copper rockfish and adult quillback rockfish in the deeper areas. Other dives were made in a narrow pass between Nelson Island and a small unnamed islet. The substrate was an irregular terrain of boulder and bedrock. There were large numbers of sub-adult quillback rockfish in the deeper sections, and pile, striped and kelp perch were common at shallower depths.

Ball Point - Hardy Island - Site 16-216

This site contained approximately 500 m of shoreline adjacent to the mouth of Jervis Inlet. The general terrain was a steep bedrock slope to a depth of 300 m. During the shallow transects terraced areas of boulders and sand were often encountered, while most of the deep transects were on

near-vertical walls. Overall, fish were not abundant, although 20 adult copper rockfish and 38 pile perch were encountered on one shallow transect. On the deep transects, groups of juvenile and subadult quillback rockfish were observed near clusters of boot sponges while adults were more generally distributed.

Temple Rock - Site 16-234

This site actually consisted of two submerged reefs - Temple Rock and Jacob Rock. Temple Rock is a flat-topped pinnacle reaching to 8 m below the surface. The substrate was generally bedrock, barren in some places and overlaid by boulders and sand in others. Agarum formed from 90% cover in the shallow areas to 50% cover on the deep transects. The highest fish densities of the survey were recorded at this site. Adult copper and quillback rockfish were abundant on most transects. YOY copper rockfish were very abundant in shallow areas near the reef crest.

Jacob Rock is at the southern end of a ridge that extends from Hodgson Islets. The area is comparable in substrate to Temple Rock, although fish and other marine life were not as abundant. Large schools of YOY copper rockfish were observed on the reef crest.

North Twin Islands - Site 15-088

This site included most of the north Twin Island shoreline, an unnamed islet, three submerged reefs and a small section of shore along Cortes Island. The 2500 m of shoreline was extremely variable in form, with areas of pebble sand, broken rock and boulders, and sheer bedrock wall. The three submerged reefs had a bedrock slope with sparse patches of boulders. One of these reefs was especially rich with encrusting invertebrates and swimming scallops, although few fish were present. Two transects were conducted on the shore of Cortes Island. At this location, the terrain had a high relief with large boulders and broken rock. High densities of copper rockfish were present in this region.

South Twin Island - Site 15-103

This site was not surveyed in 1984 (Richards et al. 1985b). It included a 3500 m shoreline along the northwest and southern end of south Twin Island. Transects along the northeastern shore were conducted over a moderate slope of broken rock and boulders that descended onto a sand/shell bottom. High densities of subadult quillback and copper rockfish (all sizes) were recorded in this area. Other transects on the south end of the Twin Islands were conducted over terraced areas of bedrock and broken rock. The area had a 10% Nereocystis cover with high densities of striped and pile perch. The understory had a moderate to high relief with a 20-70% Agarum cover. Rockfish abundance was low in this area.

Mink Island - Site 15-056

This site was included 2100 m along the northwest and south side of Mink Island. This area generally had a terraced bedrock 50° slope with sparse boulder areas. High densities of YOY copper rockfish, tube-snout, and striped, pile and shiner perch were recorded on the shallow transects. Subadult and adult quillback rockfish were very abundant on some of the deep transects. Dense patches of sponge were present on deep transects on the northwest Mink Island shore.

Tenedos Bay - Site 15-060

This site included 2700 m of shoreline adjacent to Bold Head and the southern shore along the outer part of Tenedos Bay. Transects conducted at the latter areas were on a low relief, steep to overhanging bedrock terrain. Several vertical chutes were observed that were filled with oyster shells that originated from the intertidal zone. Dogfish were very abundant in this area and 500 individuals were recorded on one dive. Perch and rockfish species were present but were not abundant. Dives conducted along the Bold Point area were among the most scenic of all dives conducted in the survey. At one location a high relief terrain of moderate slope was created by a large broken rock that originated from a 100 m high cliff (above water). In this area, four perch species, lingcod, and copper and quillback rockfish were abundant. Large numbers of dogfish were also observed in this area.

Junction Point - Cortes Island - Site 15-027

This site included approximately 1600 m of shoreline around the Junction Point light. Most of the area consisted of a broken rock and boulder slope with outcrops of terraced bedrock. Agarum formed 90% cover over most of the area. High densities of YOY rockfish were observed, and copper and quillback rockfish, lingcod and the four perch species were present but not abundant. On the southern part of Junction Point there was a low-sloping terrain of cobble, sand and boulders. YOY copper and subadult quillback rockfish were abundant and perch and adult copper rockfish were common on most dives.

Teakerne Arm - Site 15-006

This site included 1000 m of shoreline along the north side of Teakerne Arm. Log booming occurred at the eastern end of the site. Mooring cables extended from the shore and small amounts of bark and wood chips were seen along transects. The terrain generally consisted of a steep bedrock slope with terraced areas of boulders, broken rock and sand. Transects conducted on the western end of the site were on a bedrock wall that was vertical to overhanging. Few fish were observed in this latter habitat, although large numbers of subadult quillback rockfish were present in the boulder areas. YOY copper rockfish, striped and pile perch were abundant in many of the shallow areas.

OBSERVATIONS ON FISH

Fish counts were dominated by species in three families: Scorpaenidae, Hexagrammidae and Embiotocidae (Table 3, Appendix 3). These families accounted for 76.4%, 0.9% and 16.5% of the fish recorded during the SCUBA survey. Species from other families generally recorded in low abundance were dogfish, ratfish, chum salmon, tube-snout and wolf-eel. (See Appendix 3 for species names). As in 1984 (Richards et al. 1985b), large numbers of dogfish were recorded at Tenedos Bay (Site 15-60), where a total of 519 were counted, 94% of the total number observed. Tube-snout were probably present in 1984, but they were not recorded in that year.

YOY copper rockfish accounted for 70.9% of the total number of fish recorded. The transect method, however, was designed for larger fish and counts were inaccurate for this size-class. For this reason, 75% of the YOY copper rockfish were described as "off-transect" as they were further than 2 m away from the transect line. YOY copper rockfish were encountered singly, in small groups and in large schools of over 100 individuals. They tended to be associated with specific reef features such as a rock outcropping or an isolated Nereocystis plant. Fish concealed by Agarum or boulders were only visible in the immediate path of the observer, while schools were visible several meters away.

Subadult and adult copper and quillback rockfish were found in high relief habitats. These species tended to segregate by depth, with copper rockfish dominant in shallow areas and quillback rockfish dominant below 12 m. Individual copper rockfish were occasionally observed darting towards a crevice, probably avoiding the divers. However, groups of copper rockfish did not appear to be disturbed by divers. Most quillback rockfish were observed hovering above the reef surface. A few quillback rockfish were attracted to the divers and left their crevices or moved from deeper areas into the range of visibility of the divers as the divers approached.

Tiger rockfish and yelloweye rockfish were counted in small numbers. As they were usually hidden in crevices in high relief habitats, these species could have been missed by divers and counts probably underestimated true abundances. Most of the yelloweye rockfish that were observed were less than 10 cm in length and had the distinctive juvenile markings of two white stripes on a bright orange body.

The family Hexagrammidae was represented by five species: lingcod, kelp greenling, painted greenling, rock greenling and white-spotted greenling. All painted greenling were in the 10-19 cm size range and they were not included in Table 4 or Appendix 4. Only two rock greenling were observed, one at each of the Sabine Channel sites (16-102 and 16-113). Greenling began to move when approached, and as they sometimes followed the divers, double counts may have occurred in some cases. Lingcod were often observed positioned motionlessly on the reef surface. They moved away from the divers when the divers approached within a distance of about 2 m. No nesting lingcod were observed during the survey.

The family Embiotocidae was represented by four species: kelp perch, shiner perch, striped perch and pile perch. These species were usually

observed near the surface in mixed schools during shallow transects. Kelp perch, pile perch, and striped perch were highly mobile and tended to move in and out of the visual range of the diver so that accurate counts were difficult. Kelp perch were more cryptic and usually occurred in small groups of two or three fish. Kelp perch and shiner perch, not listed in Table 4 or Appendix 4, had a size range of 10-19 cm.

ACCURACY OF TRANSECT METHODS

Visual counts are known to provide a biased estimate of the size of fish populations (Sale and Douglas 1981; Brock 1982). We chose a line transect of variable width as the survey method as (1) abundances were relatively low at most sites and it was preferable to cover as large an area as possible, (2) counts could be converted to densities, and (3) it was not important to count small and cryptic species (except YOY rockfish). We assumed visibility to be an index of transect width. Data for the three measures of visibility are presented in Appendix 6. They were significantly correlated ($p<0.001$) with pattern visibility less than slate visibility which was less than white card visibility.

Transect width was not obviously related to visibility. Fish were observed at a maximum estimated distance of 8 m, although pattern visibility was as great as 14.0 m. For rockfish as a group, the maximum distance at which fish of three size-classes were observed on a dive was correlated with pattern visibility ($r=0.393$, $n=114$, $p<.001$), but the correlation was not significant for other species groups. Not all species and sizes of fish have the same observability; small cryptic or crevice-dwelling fish may only be visible when in the immediate path of the observer, while large, bright-colored or social fish may be observed at greater distances. Some species have a distinct shape and can be recognized by their silhouette. The modal distance from the transect at which copper and quillback rockfish were observed was 2 m, while kelp greenling were observed at a modal distance of 1 m. These data are presented in Appendix 7.

Another potential source of error in the survey data was in the estimation of fish size. The data included as a check on the ability of the diver to estimate size are listed in Appendix 8. Overall, there was a tendency to overestimate size by 1.3 ± 0.4 cm, or by $0.04\pm0.01\%$ of the true size. By ANOVA, there was no significant difference among dives in percentage estimation error ($p>0.10$), and by regression, there was no trend in error with increasing experience of the diver as the survey progressed ($p>0.10$). The sizes of fish listed in Table 4 and Appendix 4 are considerably larger than the sizes reported at the same sites during the 1984 contract survey (Richards et al. 1985b). Fish sizes were probably underestimated in 1984.

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LITERATURE CITED

Behrens, D. W. 1980. Pacific Coast Nudibranchs. Sea Challengers Press, Los Osos. 112 p.

Brock, R. E. 1982. A critique of the visual census method for assessing coral reef fish populations. Bull. Mar. Sci. 32: 269-279.

Butler, T. H. 1980. Shrimps of the Pacific Coast of Canada. Can. Bull. Fish. Aquat. Sci. 202: 280 p.

Gotshall, D. W. and L. L. Laurent. 1979. Pacific Coast Subtidal Marine Invertebrates. Sea Challengers, Los Osos. 107 p.

Haegele, C. W., A. S. Hourston, R. D. Humphreys, and D. C. Miller. 1979. Eggs per unit area in British Columbia herring spawn deposition. Fish. Mar. Serv. Tech. Rep. 894: 30 p.

Harbo, R. M. 1980. Tidepool and Reef Marine Life; Guide to the Pacific Northwest. Hancock House, North Vancouver, B.C. 56 p.

Hart, J. F. L. 1982. Crabs and their relatives of British Columbia. B.C. Prov. Mus. Handb. 40: 267 p.

Kozloff, E. N. 1974. Keys to the Marine Invertebrates of Puget Sound, the San Juan Archipelago and adjacent regions. Univ. of Wash. Press, Seattle. 226 p.

Kozloff, E. N. 1983. Seashore Life of the Northern Pacific Coast. Univ. of Wash. Press, Seattle. 370 p.

Lambert, P. 1981. The Sea Stars of British Columbia. B.C. Prov. Mus. Handb. 39: 153 p.

Larson, R. J. 1980. Competition, habitat selection, and the bathymetric segregation of two rockfish (Sebastes) species. Ecol. Monogr. 50: 221-239.

Morris, R. H., D. P. Abbott, and E. C. Haderlie. 1980. Intertidal Invertebrates of California. Stanford Univ. Press, Stanford. 690 p.

Richards, L. J. and A. J. Cass. 1985a. Transect counts of rockfish in the Strait of eorgia from the submersible PISCES IV, October and November 1984. Can. Data Rep. Fish. Aquat. Sci. 511: 99 p.

Richards, L. J. and A. J. Cass. 1985b. 1985 research catch and effort data on nearshore reef-fishes in the Strait of Georgia, B.C. (Statistical Areas 15 and 16). Can. MS Rep. Fish. Aquat. Sci. 1851: 68 p.

Richards, L. J., A. J. Cass, J. R. Selsby, R. van den Broek, and S. D. Loynachan. 1985a. A summary of research catch and effort data for nearshore reef fishes collected during 1984 in MSA 15 and 16 of the Strait of Georgia. Can. MS Rep. Fish. Aquat. Sci. 1833: 69 p.

Richards, L. J., J. Paul, A. J. Cass, L. Fitzpatrick, R. van den Broek, and C. Lauridsen. 1985b. SCUBA survey of rockfish assemblages in the Strait of Georgia, July to October 1984. Can. Data Rep. Fish. Aquat. Sci. 545: 91 p.

Sale, P. F. and W. A. Douglas. 1981. Precision and accuracy of visual census techniques for fish assemblages on coral patch reefs. Env. Biol. Fish. 6: 333-339.

Smith, R. I. and J. T. Carlton (eds). 1975. Light's Manual: Intertidal Invertebrates of the Central California Coast, 3rd ed. Univ. of Calif. Press, Berkely. 716 p.